Dental students’ knowledge regarding the indications for antibiotics in the management of endodontic infections


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Abstract


Aim To determine the knowledge of undergraduate Spanish dental students regarding the indications of systemic antibiotics in the management of endodontic infections.

Methodology The final year dental students from four Spanish dental schools were requested to answer a one-page questionnaire on the indications for systemic antibiotics in the treatment of endodontic infections. One hundred and seventy-five students were asked to participate in this research. Data were analysed using descriptive statistics and chi-square test.

Results One hundred and four students (93.7%) completed satisfactorily the survey and were included in the study. The average duration of antibiotic therapy was 7.0 ± 2.0 days. All respondents chose amoxicillin as the first-choice antibiotic in patients with no medical allergies, alone (47%) or associated with clavulanic acid (53%). The first drug of choice for patients with an allergy to penicillin was clindamycin 300 mg (99%). For cases of irreversible pulpite, up to 63% of students would prescribe antibiotics. For the scenario of a necrotic pulp, symptomatic apical periodontitis and no swelling, 44% would prescribe antibiotics. Almost 40% of students would prescribe antibiotics for necrotic pulps with asymptomatic apical periodontitis and a sinus tract.

Conclusions It is necessary for the Spanish schools of dentistry to improve students’ knowledge about antibiotics and their indications in endodontics. Interactive education analysing real endodontic cases using problem-based learning would help students acquire better skills in prescribing antibiotics in pulp–periapical pathosis.

Keywords: antibiotics, dental curriculum, endodontic infections, undergraduate student.

Introduction

The ESE undergraduate curriculum guidelines for Endodontology (ESE 2013) present a list of competencies that the graduating dental student is expected to have achieved. The guidelines follow the pattern adopted by the Association for Dental Education in Europe in their Profile and Competencies of the Graduating European Dentist (Cowpe et al. 2010). The guidelines recommend that students are not simply trained as technicians or ‘root canal therapists’. On the contrary, dental students should be encouraged to be aware of the factors associated with
treatment success and tooth survival and implement these within their decision-making (European Society of Endodontology 2013).

The ESE guidelines state that a graduating European dentist should be adequately grounded in basic and applied science for the safe practice of clinical dentistry and, particularly, in Endodontics. The guidelines establish that undergraduates not only should have knowledge of the microbiology of pulpits and apical periodontitis, being competent at medicating root canals for the control of microbial infection, but also of pharmacology and therapeutics as applied to the management of patients suffering endodontic infections (European Society of Endodontology 2013). Therefore, undergraduate dental student should have knowledge of the use of antibiotics in the management of microbial infections and the mechanisms and significance of antimicrobial resistance.

The dental curriculum in Spanish universities includes pharmacology, involving the study of antimicrobial drugs, in the second year of dental studies. In various subjects taught in the third, fourth, and fifth years, students learn how to apply their knowledge on antimicrobial drugs to the management of dental infections. In the final year (fifth), dental student should know the indications of systemic antibiotics as adjuvants in the treatment of endodontic infections. They should be aware, in particular, of the scientific evidence showing that antibiotics are not indicated in the treatment of irreversible pulpitis, necrotic pulps and localized acute apical abscesses (AAE 1999, Aminoshariæ & Kullid 2016, Thornhill et al. 2016, Segura-Egea et al. 2016), and, particularly, that there is no evidence supporting the use of antibiotics for pain relief in irreversible pulpitis (Agnihotry et al. 2016). Thus, ideally, dentists would be knowledgeable on this area when they graduate from dental school and begin to practice. However, lack of knowledge and inappropriate prescription patterns have been identified amongst Spanish (Rodríguez-Núñez et al. 2009, Segura-Egea et al. 2010) and European dentists (Mainjot et al. 2009, Skucaite et al. 2010, Pertic et al. 2015) and, in general, throughout the world (Segura-Egea et al. 2017), regarding the use of systemic antibiotics in the treatment of endodontic diseases. Taking into account that endodontic infections are highly prevalent (Jiménez-Pinzón et al. 2004, Segura-Egea et al. 2004, Gulsahi et al. 2008, Peters et al. 2011, López-López et al. 2012, Dutta et al. 2014) and that dentists prescribe approximately 10% of all common antibiotics (Pallasch 2000, Ajantha & Hegde 2012), dentistry’s contributions to the antibiotic resistance problem are likely to be substantial.

This situation requires not only amending antibiotic-prescribing habits of dentists in the treatment of endodontic infections, but also assessing whether dental students are being taught correctly about the indications of systemic antibiotics in the treatment of pulpitis and apical periodontitis. Otherwise, it would be necessary to modify the dental curriculum to improve dental student learning about the coherent and proper use of antibiotics in the treatment of endodontic infections and the threat of antibiotic resistance (Segura-Egea et al. 2017). New generations of dentist and endodontists must be fully aware of the increasing problem of antibiotic resistance, as they will be the future antibiotic prescribers (WHO 2012). Several studies have investigated the knowledge of medical students about antibiotic therapy (Dyar et al. 2013, Scaioli et al. 2015). However, although the preferences in the choice of antibiotics amongst dentistry students have been studied (Guzmán-Álvarez & Medeiros 2012, Jain et al. 2016), no study has analysed their knowledge regarding antibiotic use in the treatment of endodontic infections. The aim of this study was to determine the level of knowledge of undergraduate Spanish dental students regarding the indications of systemic antibiotics in the management of endodontic infections.

**Methodology**

Final year dental students from four Spanish dental schools were requested to answer a one-page questionnaire (Fig. 1) on the indications for systemic antibiotics in the treatment of endodontic infections. The only participation requirement was to be dental student in the final year of undergraduate studies. The questions were based on those asked in the previous surveys developed in the USA (Whitten et al. 1996, Yingling et al. 2002) and Spain (Rodríguez-Núñez et al. 2009, Segura-Egea et al. 2010). One trained professor of each dental school administered the questionnaires to all final year dental students attending regular classes during one specific day. The students of the last course of dentistry who did not attend class that day were not included in the study. The students who participated did so voluntarily, anonymously and without compensation. One hundred and seventy-five students were required to participate in the investigation, and 164 (94%) (University of Barcelona, n = 68; University of Sevilla,
ANTIBIOTIC IN ENDODONTIC INFECTIONS SURVEY

GENDER: Male  Female  

AGE (ys): __________ 

DENTAL SCHOOL: BARCELONA  SANTIAGO  SEVILLA  ZARAGOZA  

1. When systemic antibiotics are indicated, which antibiotic would you choose for the treatment of an endodontic infection in an adult patient with no medical allergies?
- Amoxicillin: 500 mg  750 mg  1 g  
- Amoxicillin + Clavulanic Acid: 250 mg/62.5 mg  500 mg/125 mg  875 mg/125 mg  
- Clindamycin: 300 mg  
- Azithromycin: 250 mg  500 mg  1 g  
- Metronidazole + Spiramycin:  
- Other: ____________________________________  

2. For how many days would you prescribe antibiotics? __________

3. When systemic antibiotics are indicated, which antibiotic would you choose for the treatment of an endodontic infection in an adult patient with allergy to penicillin?
- Clindamycin 300 mg:  
- Azithromycin: 250 mg  500 mg  1 g  
- Metronidazole + Spiramycin:  
- Erythromycin:  
- Lincomycin:  
- Other: ____________________________________  

4. In which of the following situations do you consider that antibiotics are indicated? Check all that apply.
- Irreversible pulpitis; moderate/severe pre-op symptoms  
- Irreversible pulpitis with symptomaticapical periodontitis; moderate/severe pre-op symptoms  
- Necrotic pulp with asymptomatic apical periodontitis; no swelling, no/mild pre-op symptoms  
- Necrotic pulp with symptomatic apical periodontitis; no swelling, moderate/severe pre-op symptoms  
- Necrotic pulp with asymptomatic apical periodontitis; sinus tract present; no/mild pre-op symptoms  
- Necrotic pulp with symptomatic apical periodontitis; swelling present; moderate/severe pre-op symptoms  

Figure 1 Antibiotic survey.

n = 36; University of Santiago de Compostela, n = 32; and University of Zaragoza, n = 28) fulfilled satisfactorily the survey and were included. A database was created for further analysis using Excel (Microsoft Corp., Redmond, WA, USA). Data description was carried out by frequency tables. When
obtaining the numerical representation by percentages, the total number of answers for each query was taken into account. Data were analysed using descriptive statistics and chi-square test. Significant differences were considered when \( P < 0.05 \).

**Results**

The demographics of the 164 respondents are described in Table 1. Male respondents \((n = 48)\) accounted for 29% and females \((n = 116)\) 71% of the total. The mean age of the respondents was 23.9 years \((SD = 2.1)\). The majority of the respondents were students from the University of Barcelona (41%).

The average duration proposed for antibiotic therapy was 7.0 ± 2.0 days, 7 days being the more frequently selected duration (69%) (Fig. 2). The standard deviation in this response indicated that the majority would prescribe antibiotics for between 6 and 8 days. Twenty percent of respondents prescribed antibiotics for more than 7 days. There were no significant differences amongst the students of the four dental schools included in the study \((P > 0.05)\).

All respondents chose amoxicillin as first-choice antibiotic in patients with no medical allergies (Table 2), alone (47%) or associated to clavulanic acid (53%). There were significant differences amongst the four dental schools \((P < 0.01)\). Amoxicillin 750 mg was the preferred first-choice antibiotic for the students of Barcelona (60%), whereas amoxicillin/clavulanic acid 875/125 mg was the first-choice antibiotic for the students of Zaragoza (50%), Santiago (66%) and Sevilla (64%). Grouping all the data, amoxicillin/clavulanic acid 875/125 mg was selected as first-choice antibiotic by 41% of respondents, whereas 30%, 14%, 12% and 4% of the students selected amoxicillin 750 mg, amoxicillin 500 mg, amoxicillin/clavulanic acid 500/125 mg and amoxicillin 1 g. No students selected clindamycin or metronidazole–spiramycin as first-choice antibiotic for nonallergic patients. On the contrary, the greatest majority of the students (99%) selected clindamycin 300 mg for penicillin allergic patients, and only 1.3% selected azithromycin \((P = 0.039)\) (Table 3).

The percentage of students who would prescribe antibiotics for various pulpal and periapical diagnoses is listed in Table 4. In the cases of patients diagnosed with irreversible pulpitis with moderate/severe symptoms or irreversible pulpitis with symptomatic apical periodontitis and moderate/severe symptoms, 29% and 63% of students, respectively, would prescribe antibiotics. There were no significant differences amongst the results of the four dental schools \((P > 0.05)\).

When the patient’s diagnosis was necrotic pulp, asymptomatic apical periodontitis, no swelling and no or mild symptoms, 16% of respondents would have prescribed antibiotics. The percentages of students who would prescribe AB in this clinical situation differ according to the dental school, being significantly lower in the students of Zaragoza and Sevilla \((P < 0.01)\).

In the situation of necrotic pulp, symptomatic apical periodontitis and moderate/severe symptoms but no swelling, 44% prescribed antibiotics. The percentage of students who would prescribe antibiotics in this situation was significantly higher in Barcelona (63%) compared to the other three dental schools \((P < 0.01)\).

For a case of necrotic pulp and asymptomatic apical periodontitis, but with the presence of a sinus tract, 38% would have prescribed antibiotics. Again, the students of Barcelona were the ones who would most prescribe antibiotics in this situation (50%) \((P < 0.05)\).

**Table 1** Description of respondents \((n = 164)\)

<table>
<thead>
<tr>
<th>Gender (%)</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>48 (29.3)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>116 (70.7)</td>
<td></td>
</tr>
<tr>
<td>Mean age (year) ± SD</td>
<td>23.9 ± 2.2</td>
<td></td>
</tr>
<tr>
<td>School of Dentistry (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barcelona</td>
<td>68 (41.4)</td>
<td></td>
</tr>
<tr>
<td>Zaragoza</td>
<td>28 (17.1)</td>
<td></td>
</tr>
<tr>
<td>Santiago de Compostela</td>
<td>32 (19.5)</td>
<td></td>
</tr>
<tr>
<td>Sevilla</td>
<td>36 (22.0)</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2** Distribution of respondents by treatment duration. There were no significant differences amongst the four dental schools \((P > 0.05)\).
Finally, in the scenario of a necrotic pulp, symptomatic apical periodontitis, swelling and other moderate/severe symptoms, 90% of dental students would prescribe antibiotics. In this case, they were the students of Zaragoza who, to a lesser extent, would prescribe antibiotics (75%) ($P < 0.01$).

There were no significant differences between respondents in the indication of antibiotics for the diverse situations of endodontic diseases in relation to age or gender ($P > 0.05$).

**Discussion**

This is the first study investigating dental students’ knowledge about antibiotic indications in endodontic infections. The analysis of the survey responses demonstrate that the majority of Spanish final year dental students selected the proper antibiotic for the treatment of endodontic infections, but there were still many who indicated antibiotics inappropriately.
The questions and the endodontic situations proposed in the present survey were based on previous surveys developed in the USA (Whitten et al. 1996, Yingling et al. 2002) and Spain (Rodríguez-Nuñez et al. 2009, Segura-Egée et al. 2010).

The population sampled in this study was Spanish final-year dental students from four Spanish dental schools from different regions of the country. Taking into account that the questionnaires were administered to students attending regular classes, the percentage of students included in the study and the overall response rate (94%) were high. Therefore, the sample (n = 164) can be considered representative of the Spanish population of dental students. Other similar surveys carried out in comparable conditions have also found very high response rates (Scaioli et al. 2015, Jain et al. 2016).

The sample size of the present study (n = 164) is similar or greater to that of other previous studies (Martínez-Beneyto et al. 2012, Scaioli et al. 2015, Jain et al. 2016), and the higher percentage of females (71%) is also similar to the percentage found in other studies carried out in Spain (Martínez-Beneyto et al. 2012). It is a reflection of the feminization that is taking place in the profession of dentistry in Spain.

The average duration for the antibiotic therapy proposed by the final-year dental students responding the survey was 7.0 ± 2.0 days, 7 days being the more frequent (69%), without significant differences amongst the dental schools (P > 0.05). This result is similar to those obtained in the surveys carried out amongst Spanish endodontists (Rodríguez-Nuñez et al. 2009) and oral surgeons (Segura-Egée et al. 2010) and in accordance with the results obtained in the studies carried out in other countries (Segura-Egée et al. 2017). However, 20% of students were confused about the duration of antibiotic treatment, prescribing antibiotics for more than 7 days. Normally, endodontic infections have a rapid onset and short duration, resolving in 3–7 days or less if the cause is treated or eliminated (Pallasch 1993, Epstein et al. 2000).

The selection of amoxicillin by 100% of respondents as the first-choice antibiotic for nonallergic patients is in agreement with the results of the survey carried out amongst the members of the Spanish Endodontics Society, who also selected amoxicillin as the first-choice antibiotic, alone (44%) or associated with clavulanate (42%) (Rodríguez-Nuñez et al. 2009) and with the answers of the members of the Spanish Oral Surgery Society who chose amoxicillin, alone (34%) or associated to clavulanic acid (61%) (Segura-Egée et al. 2010). Surveys carried out amongst European dentists in other countries (Tulp & Palmer 2008, Mainiot et al. 2009, Skucaite et al. 2010, Kaptan et al. 2013, Segura-Egée et al. 2017) concluded that amoxicillin is the first-choice antibiotic selected for European dentists for the treatment of endodontic infections. On the contrary, surveys carried out amongst dental students in other continents have found lower percentages of amoxicillin as first-choice antibiotic. The study developed by Guzmán-Álvarez & Medeiros (2012) amongst fourth-year students at the School of Dentistry at the Universidad Nacional Autónoma de México found that 78.9% of students selected amoxicillin as first-choice antibiotic for the treatment of odontogenic infections, ampicillin being selected as first-choice antibiotic by 10.6% of students. On the other hand, only 46.5% of the third and final year dental students of Teerthanker Mahaveer Dental College and Research Centre in Moradabad (Uttar Pradesh, India) selected amoxicillin as first-choice antibiotic, followed by penicillin V (19.4%) (Jain et al. 2016). Indian dentists also preferred amoxicillin as the first antibiotic of choice in patients with no medical allergies, but followed by ofloxacin/ornidazole (Kumar et al. 2013, Jayadev et al. 2014).

Although amoxicillin is a good drug for the treatment of endodontic infections, its antimicrobial activity against bacteria involved in pulp–periapical pathosis is decreasing due to the development of β-lactamase producing bacteria. Therefore, the combination of amoxicillin plus clavulanic acid, a β-lactamase inhibitor, is recommended (Gilbert et al. 2003, Maestre Vera 2004), being the first option for endodontic infections (Kuriyama et al. 2007, Stein et al. 2007). Baumgartner & Xia (2003) found 100% of susceptibility to amoxicillin/clavulanic acid for 98 bacterial species isolated from endodontic infections. However, the association of co-amoxiclav with increased risk of Clostridium difficile infection recommended to be reserved for immunocompromised patients and nonrespondent patients to amoxicillin alone (Gordon 2010, Segura-Egée et al. 2016).

The first antibiotic of choice for β-lactam allergic patients was clindamycin 300 mg, selected for almost all the students (99%). The results of the surveys conducted previously in Spain amongst endodontists and oral surgeons found that 63% and 65%, respectively, of dentists selected clindamycin as first-choice antibiotic for allergic patients. Clindamycin and erythromycin are the two worldwide most preferred antibiotics for the treatment of pulp–periapical
pathosis (Segura-Egea et al. 2017). However, lincosamides such as clindamycin must be the antibiotic of choice, when needed, for the management of endodontic infections (Segura-Egea et al. 2016).

Regarding the indications of antibiotics as adjunct in endodontic therapy, several studies carried out in different countries have found a lack of knowledge and inappropriate antibiotic-prescribing patterns amongst dentists for endodontic infections (Al-Haroni & Skaug 2006, 2007, Mainjot et al. 2009, Rodríguez-Núñez et al. 2009, Segura-Egea et al. 2010, 2017, Skucaite et al. 2010, Iqbal 2015, Perić et al. 2015). Most of these studies concluded that it is necessary to amend antibiotic-prescribing habits of dentists in the management of endodontic diseases. Nevertheless, it is also essential to develop new strategies to improve the knowledge of dental students on the indications of antimicrobial drugs in the treatment of pulpitis and apical periodontitis. Therefore and first, it is crucial to know the real knowledge of dental students on this topic.

In the present study, the percentages of students prescribing antibiotics for the six proposed pulpal and periapical diagnoses reveals that it is necessary revise the dental curriculum to enhance dental student learning on antibiotic use in endodontics. In the first and secondly proposed clinical situations, that is irreversible pulpitis with moderate/severe symptoms or irreversible pulpitis with symptomatic apical periodontitis, 29% and 63% of students, respectively, would prescribe antibiotics. However, these pulps are still vital, and the patients have no signs of systemic involvement, so antibiotics are not indicated in these situations (Keenan et al. 2005, Agnihotry et al. 2016, Segura-Egea et al. 2016). This result reveals that a significant percentage of final year dental students ignores the scientific basis for prescribing antibiotics in endodontics.

The following situation that was raised in the survey was a patient with necrotic pulp, asymptomatic apical periodontitis, no swelling and no/mild symptoms. Sixteen per cent of students responded that they would indicate antibiotics. Once more, this situation involved a healthy patient and no indication for antibiotic exists (Agnihotry et al. 2016, Segura-Egea et al. 2016). Root canal treatment should be enough. The percentage is similar to that of Spanish endodontists prescribing antibiotics in such situation (14%) (Rodríguez-Núñez et al. 2009). On the contrary, the percentage of Spanish oral surgeons prescribing antibiotics in patients with the same clinical situation was double (31%) (Segura-Egea et al. 2010).

The fourth case, necrotic pulp and symptomatic apical periodontitis with moderate/severe symptoms but no swelling, should also require only root canal treatment and analgesics (Agnihotry et al. 2016, Segura-Egea et al. 2016). However, 44% of students would prescribe antibiotics to a patient suffering from this clinical manifestations. This percentage indicates that almost a half of dental students had the incorrect concept for antibiotic prescribing in endodontics. However, taking into account that previous studies have found higher percentages (53–71%) of Spanish dentists (Rodríguez-Núñez et al. 2009, Segura-Egea et al. 2010) prescribing antibiotics in this situation, it seems that future dentists have, comparatively, a better knowledge in this topic. But it may also be relevant that, after they begin their clinical practice as dentists, they will be encouraged by patients, or their relatives and companions, to overprescribe antimicrobials for irreversible pulpitis and acute apical periodontitis (Lewis 2008). It must be taken into account that the reason for antibiotic prescription is infection, but in fact, pain is the patient’s main complaint in endodontics (Guzmán-Álvarez & Medeiros 2012).

The fifth clinical situation, a case of necrotic pulp and asymptomatic apical periodontitis, with the presence of a sinus tract, requires nonsurgical root canal treatment, but no antibiotics (Agnihotry et al. 2016, Segura-Egea et al. 2016). Thirty-eight per cent of students would have prescribed antibiotics in this case. This percentage is higher than that of Spanish endodontists (21.4%) (Rodríguez-Núñez et al. 2009), but it is almost twice that of Spanish oral surgeons (Segura-Egea et al. 2010).

The clinical situation of the sixth and final scenario, a necrotic pulp, symptomatic apical periodontitis, swelling and moderate/severe symptoms, was treated with antibiotics by 90% of dental students. Undoubtedly, the presence of systemic involvement indicates antibiotics in addition to root canal treatment, incision and drainage (Yingling et al. 2002, Agnihotry et al. 2016, Segura-Egea et al. 2016).

Endodontic infections are polymicrobial, involving both gram-positive and gram-negative facultative anaerobes and strictly anaerobic bacteria (Siqueira et al. 2008). The use of systemic antibiotics as an adjunct to endodontic clinical treatment is indicated to prevent the spread of infection, such as in cases of acute apical abscesses with systemic involvement and in progressive and persistent infections (Zeitoun & Dhanarajani 1995, Agnihotry et al. 2016, Segura-Egea et al. 2016). On the contrary, patients suffering
from irreversible pulpitis, necrotic pulps or localized acute apical abscesses do not need antibiotics (Cope et al. 2014, Agnihotry et al. 2016, Segura-Egea et al. 2016). Antibiotics should be also considered in immunocompromised patients in which the immune system needs help to remove bacteria (Mohammadi 2009) or in patients with a localized congenital or acquired altered defence capacity (Segura-Egea et al. 2016).

The results of the present study show that it is necessary for the schools of dentistry in Spain to work with endodontic and pharmacology departments, as well as with the other academic departments, to improve students’ knowledge on antibiotics and their indications in endodontics. On the other hand, little is known about the contents and quality of medical and dental curriculum teaching on the principles antimicrobial stewardship and resistance in terms of knowledge, attitude and behaviour to medical or dental students (Pulcini & Gyssens 2013). The review carried out by Lee et al. (2015) concluded that there was no study measuring the effectiveness of an educational programme on antibiotic prescribing for medical or dental students. The survey conducted amongst medical students’ in a US university hospital about perceptions and attitudes on their training on antimicrobial use (Minen et al. 2010) concluded that medical students knew the importance of prudent antibiotic use and would like greater instruction on this issue.

Interactive education analysing real endodontic cases in the classroom using problem-based learning would be appropriate for this subject, helping undoubtedly students to acquire better skills in prescribing antibiotics in pulp–periapical pathosis (Jain et al. 2016). The development of the formal curriculum of dental schools on antibiotic use and resistance, as it has been developed in some medical schools, is required. In the Netherlands, the University of Nijmegen has a programme-based module on antibiotic policy treating the history of infectious diseases and antibiotic guidelines (Pulcini & Gyssens 2013).

A factor that may also influence the overprescription of antibiotics is the pressure imposed by the community and the excessive and unreasonable demand for antibiotics by patients. Therefore, it seems important that dental student should be educated more effectively in managing the unreasonable expectations and demands of patients as they leave dental school and enter a world where less than responsible prescribing is commonplace.

Conclusions

The dental curriculum should provide more focus on prescribing and teaching good prescription practices to dental students. The development of educational electronic tools providing direct access to precise information and standardized teaching materials for prudent antimicrobial prescribing, such as the UK’s Prudent Antibiotic User (PAUSE 2007, http://www.pausenline.org.uk) website, would increase knowledge of antibiotic prescribing in undergraduate dental and medical students.

Conflict of interest

The authors have stated explicitly that there are no conflict of interests in connection with this article.

References


